Endangered Species Act - Section 7

BIOLOGICAL OPINION

Howard Hanson Dam and Additional Water Storage Project
WSB-00-198

Agency: U.S. Army Corps of Engineers, Seattle District

Consultation Conducted By: National Marine Fisheries Service
Northwest Region, Washington State Habitat Branch

Approved: For Michael R Crouse
Donna Darm
Acting Regional Administrator

Date: 10/24/[illegible]

TABLE OF CONTENTS

I. BACKGROUND AND DESCRIPTION OF THE PROPOSED ACTION

A. Consultation History

This document is the National Marine Fisheries Service's (NMFS) biological opinion for the Howard Hanson Dam (HHD) operations and maintenance and proposed Additional Water Storage Project (AWSP). The objective of this biological opinion is to determine whether continuing operation and maintenance and the proposed AWSP and conservation measures are likely to jeopardize the continued existence of the Puget Sound chinook salmon or result in the destruction or adverse modification of their critical habitat.

The U. S. Army Corps of Engineers (Corps) previously prepared a draft Biological Assessment (BA) for the AWSP in 1998. Informal consultation through inter-agency meetings in 1999 led to the preparation of the present Programmatic Biological Assessment (PBA), encompassing operation and maintenance of the existing project without conservation measures, the existing project with conservation measures, the proposed AWSP without conservation measures, and the AWSP with conservation measures. Uncertain as to how to frame the proposed action and proceed in to consultation with NMFS, the Corps' PBA described several actions and the requested consultation on the resultant multiple effects determinations. This uncertainty was partially the result of the fact that the ongoing operations and maintenance activities at the HHD had not previously been subject to formal consultation under the Endangered Species Act.

The PBA was submitted to NMFS April 5, 2000. NMFS and the Corps met again on May 2, 2000 in an effort to frame the proposed action so that NMFS could consult on a single effects determination. The Corps, by a letter dated May 17, 2000, modified the PBA to describe a single analysis and effect determination for the operation and maintenance of the existing project and proposed AWSP with conservation measures. This is the project configuration and proposal analyzed in this BO. Because the proposed action includes, in part, ongoing operations and maintenance, the effects analysis for many of the parameters analyzed is the same as the environmental baseline. The proposed action includes a framework for a proposed sediment management plan that would be developed by the Corps in the first two years after completion of this formal consultation. The framework is described in a supplement to the PBA. The framework proposes measurable targets for sediment routing through the reservoir at the HHD project. To achieve these targets, the Corps proposes to develop a plan providing commitments for monitoring, adaptive management, and modification of operations to ensure achievement of the sediment routing targets.

B. Elements of the Proposed Action

1. Maintenance and Ongoing Operations

Howard Hanson Dam (HHD) was completed in 1962 by the Corps to provide downstream flood protection and augment flows in the lower Green River. The project is located in southeastern

King County, approximately 45 miles from Seattle, Washington (Figure 2-1). The dam is located at River Mile (RM) 64.5 in Section 28, Township 21 North, Range 8 East, Willamette Meridian. The project site lies within the City of Tacoma (Tacoma) municipal watershed and access to much of the over 220 square miles of watershed above HHD is closed to the public. From RM 64.5, the Green River flows west and north from the Cascade Mountains to join with the Black River to form the Duwamish River. The Duwamish River then empties into Puget Sound 12 miles downstream at Elliott Bay.

HHD is currently operated to provide winter and spring flood control and summer low-flow augmentation for fish resources. Flood control operations are managed so that the dam release combined with downstream inflow doesn't exceed 12,000 cubic feet per second (cfs) at the Auburn U.S. Geological Survey (USGS) gage at RM 32. The dam has flood storage of up to 106,000 acre feet (ac-ft).

Winter operation is determined by flood control requirements. During the spring, the project switches to its secondary purpose of conservation storage for low-flow augmentation. The existing reservoir provides for 25,400 ac-ft of summer/fall storage; 24,200 ac-ft is active storage available for enhancing instream flows below the project. During the switch from flood control to conservation storage the amount of water released from HHD is reduced below the level of inflows, allowing the reservoir to refill. Refill timing and release rates are based on target instream flows that are adjusted yearly in response to the existing weather conditions, snowpack, amount of forecasted precipitation, and input on biological conditions from agency and tribal resource managers (Corps 1998a).

Section 1135 of the Water Resources Development Act of 1986 authorizes fish and wildlife enhancement measures at existing water development projects. The Corps has completed a Section 1135 Project which authorizes an additional 5,000 ac-ft of summer storage at HHD during selected years (e.g., initially during drought conditions expected in one out of five years) for a total active storage volume of 29,200 ac-ft. The project adds incremental habitat benefits by increasing the water supply available to augment low summer flows in the lower Green River, improves debris collection and management, and enhances water quality delivered to Tacoma's downstream municipal water supply diversion. The adaptive management provisions of the 1135 project allow the additional storage frequency to be increased to an annual basis if shown to be beneficial to natural resources.

2. Additional Water Storage Project

The AWSP consists of two phases. Together, both phases would provide up to 32,000 additional ac-ft over existing storage by raising the existing summer conservation pool 30 feet (from 1,147 feet to 1,177 feet). Phase I includes construction of the downstream fish passage facility at the dam, and storage would be increased by up to 20,000 ac-ft for municipal water supply. It would also include the optional storage of up to 5,000 ac-ft of water every year for low-flow augmentation purposes to benefit downstream fishery resources. In Phase II, an additional 12,000 ac-ft (9,600 ac-ft for flow augmentation for instream resource benefits, and 2,400 ac-ft for

municipal and industrial [M&I] water supply) of storage would be added to the Phase I conditions (Table 2-1). The PBA addresses only Phase 1 of the AWSP.

The AWSP, a combined water supply and restoration project, was reviewed by and included a collaborative decision-making process involving NMFS, U.S. Fish and Wildlife Service (USFWS), Washington Department of Ecology (Ecology), Washington Department of Fish and Wildlife (WDFW), the Muckleshoot Indian Tribe (MIT), Tacoma, and Corps. This process resulted in the phased adaptive management plan that provides early outputs of water supply and restoration benefits with an opportunity to review and adjust the project based on experience. The plan includes experimentation, monitoring and analysis, followed by adjustment to the management and operation practices.

Up to 20,000 ac-ft of Phase I municipal and industrial water would be stored in the spring for release during the summer and fall to supply up to 100 cfs (65 million gallons per day (mgd)) for Tacoma's Second Diversion Water Right (SDWR). The water surface elevation of the HHD pool would be raised by 20 feet (from elevation 1,147 feet to 1,167 feet). Tacoma would exercise its SDWR when municipal water is being stored during spring reservoir refill. The stored water would then be released for immediate withdrawal during the summer and fall when Tacoma has a greater need for the water.

Phase I of the AWSP includes downstream fish passage facilities at HHD, as well as a number of habitat restoration and mitigation projects. As part of Tacoma's agreement with the Muckleshoot Indian Tribe regarding Tacoma's water rights, Tacoma will trap upstream migrating adult salmon and steelhead at Tacoma's headworks, located 3.5 miles downstream, and transport them for release in or upstream of the HHD reservoir.

3. Integrated Conservation Measures

The proposed action includes the following conservation measures, each of which is more fully described in the PBA:

1) Manage water storage and release at HHD to minimize adverse effects on salmonids.
   a) maximize outflow through the fish passage facility by minimizing the reservoir refill rate during smolt out-migration and potential use of periodic artificial freshets that mimic natural freshets;
   b) increase downstream survival of out migrating salmonids by maintaining a target base flow and provide the option to release periodic freshets during peak out-migration;
   c) partially mitigate downstream effects of storage by maintaining a target base flow that improves side channel and lateral mainstem rearing habitats;
   d) provide adequate base flows through the steelhead incubation period that protect eggs deposited during higher spawning flows;
   e) provide annual storage of 5,000 ac-ft for low-flow augmentation (currently Section 1135 Project water is stored during drought conditions expected once every five years);

f) reconnection of approximately 3.4 acres of side-channel habitat to the mainstem lower Green River;
g) habitat rehabilitation including large woody debris (LWD) placement and excavation or reconnection of off-channel habitats to selected streams between the elevations of 1,177 feet and 1,240 feet.

2) Provide gravel augmentation of up to 8,000 cy downstream of HHD at Palmer and Flaming Geyser.

3) Develop and implement a Sediment Management Plan according to the framework provided in the PBA. The sediment management plan would be developed by the Corps in the first two years after completion of this formal consultation. The framework proposes measurable targets for sediment routing through the reservoir at the HHD project. To achieve these targets, the Corps proposes to develop a plan providing commitments for monitoring, adaptive management, and modification of structures or operations to ensure achievement of the sediment routing targets.

4) Transport all LWD that accumulates at HHD around HHD, including up to five truckloads of smaller woody debris per year.

5) Include temperature control capability in downstream fish passage facility.

6) Construct and operate upstream fish passage at Tacoma's headworks dam.

7) Construct and operate downstream fish passage facility at HHD to operate through the elevation range of 1080 to 1177 feet.

8) Provide the monitoring functions for the above and other elements as described in the PBA.

9) Additional habitat improvement actions:
a) return of the river to its historic channel between RM 83.0 and 84.0 using one or more debris jams/flow deflectors;
b) maintenance of instream and riparian corridor habitat within the reservoir inundation zone (elevation 1,141 feet to 1,167 feet);
c) maintenance of stream and riparian corridor habitat in lower Page Mill Creek, creation of a series of new, smaller ponds, and addition of woody debris to the ponds and stream channel;
d) replacement of culverts that constitute barriers to upstream or downstream fish passage in tributaries to the Green River (locations to be identified from a culvert inventory);
e) improvement of habitat in the mainstem Green River above and below HHD by constructing engineered log-jams and limited excavation to recreate meanders or backwater habitats;

All Phase I restoration and mitigation projects would be monitored for at least 10 years, and some up to 50 years, after implementation depending on the project. Some of the activities also require pre-construction studies and monitoring, which are currently underway or planned. The Corps and Tacoma would cost-share fish passage project monitoring, and Tacoma would entirely fund monitoring and maintenance of the fish and wildlife mitigation and restoration projects. Responsibility for implementation of the monitoring efforts would be shared by Tacoma and the Corps, with the work being conducted by either Tacoma staff, Corps staff, agencies, or contractors. All monitoring activities would be conducted in cooperation with the MIT and federal and state agencies.

II. STATUS OF THE SPECIES AND CRITICAL HABITAT

The listing status, biological information, and critical habitat elements for the Puget Sound chinook salmon are described in Table 1.

Species (Biological Reference)	**Listing Status Reference**	**Critical Habitat Reference**
Chinook Salmon from Washington, Idaho, Oregon and California, (Meyers, *et al.* 1998).	The Puget Sound ESU is listed as Threatened under the ESA by the NMFS, (64 Fed. Reg. 14308, March 1999).	Critical Habitat designated for the Puget Sound ESU, (65 Fed. Reg. 7764, February 16, 2000).

Table 1. References to Federal Register Notices containing additional information concerning listing status, biological information, and critical habitat designations for listed and proposed species considered in this biological opinion.

III. EVALUATING PROPOSED ACTIONS

The standards for determining jeopardy are set forth in section 7(a)(2) of the ESA as defined by 50 C.F.R. Part 402 (the consultation regulations). NMFS must determine whether the action is likely to jeopardize the listed species and/or whether the action is likely to destroy or adversely modify critical habitat. This analysis involves the initial steps of (1) defining the biological requirements and current status of the listed species, and (2) evaluating the relevance of the environmental baseline to the species' current status.

Subsequently, NMFS evaluates whether the action is likely to jeopardize the listed species by determining if the species can be expected to survive with an adequate potential for recovery. In making this determination, NMFS must consider the estimated level of mortality attributable to: (1) collective effects of the proposed or continuing action, (2) the environmental baseline, and (3) any cumulative effects. This evaluation must take into account measures for survival and recovery specific to the listed salmon's life stages that occur beyond the action area. If NMFS finds that the action is likely to jeopardize, NMFS must identify reasonable and prudent alternatives for the action.

Furthermore, NMFS evaluates whether the action, directly or indirectly, is likely to destroy or adversely modify the listed species' designated critical habitat. The NMFS must determine whether habitat modifications appreciably diminish the value of critical habitat for both survival and recovery of the listed species. The NMFS identifies those effects of the action that impair the function of any essential element of critical habitat. The NMFS then considers whether such impairment appreciably diminishes the habitat's value for the species' survival and recovery. If NMFS concludes that the action will adversely modify critical habitat it must identify any reasonable and prudent measures available.

Guidance for making determinations on the issue of jeopardy and adverse modification of habitat are contained in *The Habitat Approach, Implementation of Section 7 of the Endangered Species Act for Actions Affecting the Habitat of Pacific Anadromous Salmonids*, August 1999.

For the proposed action, NMFS' jeopardy analysis considers direct or indirect mortality of fish attributable to the action. NMFS' critical habitat analysis considers the extent to which the proposed action impairs the function of essential elements necessary for migration and spawning of the listed salmon under the existing environmental baseline.

A. Biological Requirements

The general biology and biological requirements of chinook salmon are described in detail by Groot and Margolis (1991). Basic biological requirements of anadromous fish, including chinook salmon, include unimpeded access to and from the sea, an adequate flow of clean water, sufficient food and cover, and suitable spawning gravels. These essential requirements are present throughout most of the Green River basin, except that unimpeded access to the upper Green River is precluded by the presence of the Tacoma headworks dam at RM 61 and Howard Hanson Dam at RM 64.5. Other human development conditions throughout the watershed compromise the quality, and occasionally the quantity, of these essential requirements, but the effects are generally less obvious.

Green River chinook are classified as a summer/fall stock and primarily express an ocean type life history (Lister and Genoe 1970; Healey 1991). Migration of adult fish is from late June through November (Grette and Salo 1986), and peak spawning is from early September through mid-November. Juvenile out-migration extends from February through June.

B. Status of the Species in the Action Area

The Action Area for this consultation consists of areas that would be either directly or indirectly affected by the proposed action including continued present operations and maintenance of HHD, development and operation of the AWSP, and the proposed integrated conservation measures (50 C.F.R. 402.02). Accordingly, the action area consists of the Green River watershed upstream of HHD, HHD and associated Corps facilities, and the mainstem Green River and associated flood plain areas downstream of HHD to the Duwamish estuary that are inundated by flows of up to 12,000 cfs.

The Green River summer/fall chinook salmon are part of the Puget Sound Evolutionarily Significant Unit (ESU). Overall, abundance of chinook salmon in this ESU has declined substantially, and both long- and short-term abundance are predominantly downward. These factors have led to this ESU as listed as threatened under the ESA (63 Fed. Reg. 11482, March 9, 1998). Chinook salmon within the Duwamish/Green River basin originated from both naturally producing native and hatchery fish (i.e., are of "mixed origin"). However, the hatchery stock of chinook salmon is currently believed to have descended from the indigenous run (Grette and Salo 1986). Escapement in the mainstem Green River averaged 7,600 from 1987 through 1992 with a trend toward increasing escapement (WDFW et al. 1994). In its review of the Puget Sound chinook ESU, NMFS classified the Green River stock as healthy based on high levels of escapement (Myers et al. 1998). NMFS is reconsidering its classification of Green River chinook, however, because of the significant proportion of stray hatchery fish in the naturally spawning population (Derek Poon, pers. comm.). NMFS considers that hatchery stray rates exceeding 9% are inconsistent with viable self-sustaining natural populations. The Green River hatchery stray rate is estimated to exceed 30%, but the extent natural production is actually sustained by hatchery straying is unknown.

NMFS' ESA implementing regulations specify that unoccupied areas are not to be included in critical habitat unless the present range would be inadequate to ensure the conservation of the species (50 C.F.R. 424.12(e)). The Green River upstream of Howard Hanson Dam was designated critical habitat because trap and haul operations moved listed chinook salmon above this dam during the 1980s and 90s (65 Fed. Reg. 7764, February 16, 2000). The brood source for the hauled fish were a mix of natural and stray hatchery spawners from Soos Creek, a tributary of the Green River. The presence of an unknown proportion of naturally produced fish (that is, listed wild chinook versus the unlisted hatchery fish) was a key trigger for designating critical habitat in the upper basin despite chinook absence for several decades.

Chinook salmon were historically distributed throughout the accessible reaches of the watershed. Since about 1912, chinook have been confined to the section downstream of Tacoma's headworks water diversion dam near River Mile 61, which blocks upstream passage. Naturally spawning chinook salmon occur in the Green River from downstream of Auburn up through the gorge to just below the headworks dam. A preponderance of the natural spawning occurs in Soos Creek and just downstream of the its confluence with the mainstem Green. Juvenile chinook rearing is distributed throughout the accessible portions of the river, its side channels, and tributaries. Chinook abundance upstream of the lower gorge is generally low because of smaller spawning escapements to this reach of the river. Chinook are not found upstream of the headworks dam or Howard Hanson Dam except when juvenile fish have been deliberately stocked there. Access above the headworks dam ended in 1912, and Howard Hanson was developed in 1962, after the upper basin population segment was extirpated.

C. Factors Affecting the Species within the Action Area

The Green River is one of three historic primary hydrologic units tributary to the Duwamish River and Elliot Bay. The White River has changed course many times historically and formerly joined the Green River near the town of Auburn but changed its course to become a tributary of

the Puyallup River in about 1908. Development has fixed the location. The Green River joined the Black River, the historic outlet of the Lake Washington drainage, between Renton and Tukwila, forming the Duwamish River. The lowering of Lake Washington disconnected most of the Black River drainage from the Duwamish system. A portion of that drainage into the Duwamish is maintained by a pump station. The present day Green River transitions into the Duwamish near Tukwila with little notice in the aquatic landscape.

Chinook habitat in the Green River is adversely affected by numerous factors from Elliot Bay to the ridge crests of the upper river basin. Those factors include urban and industrial development within Elliot Bay and the Duwamish River estuary that decrease and degrade critical juvenile chinook habitat, leaving less than 10% of the historic abundance of that habitat type. The Duwamish and lower Green River are diked and levied nearly continuously to points upstream of Auburn, disconnecting the flood plain, constricting the river channel and side channels from habitat forming and maintenance opportunities. The result is a reduction in both the quantity and quality of spawning and rearing habitat. The lower valley and estuarine wetlands have been drained and filled for agricultural and urban development. Road building and forest practices have contributed to higher rates of sedimentation in stream gravels. Blockages by water diversions and dams and shifts in the flow regime have affected habitat range, quantity, and quality. The dams have reduced the supply of coarse sediment that maintains spawning habitat, particularly in the steeper gradient downstream reach. They have likewise reduced the supply of large woody debris (LWD) to the lower river.

The Green River upstream of Howard Hanson Dam retains good potential habitat function for chinook salmon spawning and rearing if passage and access problems are addressed. Stream flows upstream of HHD reservoir are unaffected by the project and differ from pre-project conditions only through the effects of timber harvesting and road building in the watershed. Seasonal low flows are expected to be somewhat exacerbated, and fine sediment concentrations in spawning gravels elevated and frequency of large volume pools reduced. These conditions would still be expected to fall well within the range of productive chinook salmon habitat.

D. Environmental Baseline

The baseline for this analysis includes HHD and associated structures and all operation and maintenance actions prior to this consultation. The future presence of structural aspects of HHD are also part of the baseline. However, the proposed operational and maintenance actions and the development and operation of the AWSP are all future actions for the purposes of this consultation, and therefore are not part of the environmental baseline.

The baseline includes a diminished and degraded estuary, channelized lower mainstem river with fewer side channel habitats, altered hydrograph and thermal environment, increased concentrations of fine sediments in spawning gravels, interrupted sediment transport, and permanent barriers to migration at headworks dam and HHD. The baseline condition includes the absence of chinook salmon from the upper basin for a period of seven decades. The baseline condition also includes the development and operation of the Soos Creek salmon hatchery for over 100 years.

The baseline includes upper basin environments that are part of Habitat Conservation Plans (HCP) intended to protect and improve habitat conditions for listed species such as chinook salmon. Such plans cover land owned by Plum Creek Timber Company and lands managed by and covered by the Washington Department of Natural Resources HCP. Other HCPs are in preparation, and therefore, are not part of the environmental baseline.

IV. EFFECTS OF THE ACTION

The ESA implementing regulations define "effects of the action" as "the direct and indirect effects of an action on the species or critical habitat together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline". "Indirect effects" are defined as those that are caused by the proposed action at a later time, but still are reasonably certain to occur (50 C.F.R 402.02).

A. Direct Effects

Direct effects are the immediate effects of the project on the species or its habitat. Direct effects result from the agency action and include the effects of interrelated and interdependent actions. Future Federal actions that are not a direct effect of the action under consideration (and not included in the environmental baseline or treated as indirect effects) are not evaluated. Elements of ongoing HHD operations that would be influenced under the proposed action include fish passage, flood control, and water storage. In turn, elements of the environment that would be directly affected by the proposed action include habitat access, sediment transport (turbidity and sedimentation), gravel transport, large woody debris transport, channel morphology, flows, and water quality (factors in addition to turbidity).

Fish passage

The proposed action would improve existing upstream and downstream fish passage by including passage facilities for adult and juvenile fish passage. The planned facilities include the construction and operation, funded by Tacoma, of an adult fish trap and haul fishway at the upstream end of the Tacoma headworks dam. Fish that enter the trap would be transported around to a point upstream of HHD for release. Since such upstream passage is presently foreclosed at by the existing project at HHD, the effects of this element of the proposed action include substantial improvement in upstream access to habitat.

A fishway for downstream passage is also proposed under the proposed action. Fish Guidance Efficiency (FGE) is the proportion of migrating fish entering the reservoir that are safely and effectively passed around the dam. FGE can be used as a metric for estimating the effects on sustainability of particular salmonid stocks relative to pre-existing passage barriers. A higher FGE percentage can correlate with a higher number of fish that successfully pass an existing barrier. The more fish that successfully pass a barrier, the lower the effects of that barrier as a hindrance to stock sustainability.

FGE for the proposed Modular Inclined Screen (MIS) and Howard Hanson reservoir is estimated at 86% for juvenile coho, 88% for steelhead, and 64% for chinook. These figures are near the low end of the range of acceptable correlation between FGE and stock sustainability. Even so, this FGE might enable chinook to achieve natural self sustaining status upstream of HHD under contemporary ocean survival rates. With improved ocean survival conditions at the estimated FGE, the chinook run would achieve a high likelihood of sustainability.

Flood control

Under continuing flood control operations at the HHD, the Corps would operate HHD to control winter and spring flood flows to no more than 12,000 cfs at Auburn. Historic flood flows have been higher, and peak inflow to HHD in 1996 was 29,000 cfs.

The effect of flood control on chinook is complicated by the overlap of several life history characteristics and habitat parameters. Fall and winter floods have the potential to affect chinook during the adult upstream migration and their spawning activity. The probable potential effect of fall and early winter floods then is to influence salmon to spawn in sub-optimal areas. Furthermore, flood flows also mobilize substrate and debris, causing the scouring of spawning redds in vulnerable locations, resulting in the direct loss of eggs or alevins. Therefore, controlling the extent and reducing the effects of flood flows should be beneficial to the species, except to the extent that the duration of scouring flows is increased by reducing the instantaneous peak and prolonging the runoff.

Much of the lower river channel has been modified through the construction of dikes and levees. These structures moderate or prevent overbank flooding in some river reaches downstream of HHD. Overbank flooding moderates or prevents the higher water surface elevations and water velocities which can cause scouring of chinook salmon redds. To the extent that these resultant higher velocities occur in chinook spawning areas, the potential benefits of flood control operations through the HHD project are diminished (although to an unknown degree) by the presence of the levee system and lack of overbank flooding.

Flood flows are also deleterious to emergent chinook fry. The effects of controlling flood flows at the HHD project would be similarly beneficial to chinook fry. However, as mentioned immediately above, the presence of flood control structures downstream of the HHD project limit or eliminate access to shallow, slow velocity refuge habitat. Certainly, these structures help prevent the stranding of juvenile fish when compared to rivers that can occasionally overflow their banks. Furthermore, deeper water within leveed river reaches and higher water velocities would benefit active migrants in the early to late spring, by assisting downstream migration when floods are less common. Nevertheless, high flood discharges during the November through January winter flood season would tend to force early emergent fry into the estuary before sufficient freshwater rearing has occurred.

Spring Storage

Under the AWSP, water storage at the HHD project and associated reservoir would begin in mid-February, after the major threat of seasonal flooding. Generally, the Green River is not prone to significant spring floods. As a result, storing water during this time reduces average spring flows for juvenile chinook out-migration in the lower river. Wetherall (1971) found a positive correlation between spring migration flows and migrant chinook survival. Storing spring runoff is estimated to reduce average juvenile chinook survival in March but increase it in April and May for a net increase of 2.4% (Hilgert, pers. comm. 1997). Spring storage is expected to contribute to reduced FGE of juvenile chinook past HHD. This effect has to be weighed against the benefits of summer conservation flows. The expanded reservoir size under the proposed AWSP is expected to incrementally reduce juvenile fish passage FGE. Dilley and Wunderlich (1992, 1993) noted decreasing juvenile passage efficiency with increasing size of the storage pool and reservoir length.

Fine Sediment Transport

HHD will continue to modify the transport of fine sediments past the project site. Much of the fine sediment occurs in suspended form in the water column and is transported through the reservoir. Under the AWSP, storage will begin earlier in the year. Flows are higher earlier in the year, with a higher probability of flows carrying suspended fine sediments. A greater proportion of the fine sediments may fall out of suspension and settle in the reservoir. As the reservoir is drafted after flood events, fine sediment is remobilized and transported downstream of the project on the descending limb of the hydrograph, rather than the ascending limb, increasing the likelihood of fine sediment being deposited in the active river channel where it may adversely affect chinook salmon, particularly during egg incubation. The periodic release of fine sediments from reservoir storage occurs out of synch with its seasonal occurrence and concentration. Such releases can contribute directly to reduced water circulation, oxygenation and removal of waste metabolites from chinook redds. Therefore, the continuing operations and maintenance of the project could cause the take of chinook with the existing low level outlets.

The proposed Sediment Management Planning framework acknowledges the risks to salmonids associated with restoring fine sediment routing to the Green River. The Corps presently proposes coordination with NMFS and USFWS on an annual basis before undertaking routing actions. However, the specific methods and actions to minimize the effect to listed species remain to be developed. Therefore, the effect of the sediment routing action cannot be estimated in this BO, and therefore represents a basis for reinitiating consultation when the sediment management plan is fully developed.

Induced fine sediments could result under the proposed gravel augmentation measures. (The effects of the gravel augmentation proposal is discussed immediately, below). The current proposal is to place pit run gravel at two locations, Palmer and Flaming Geyser. Pit run gravel may contain fine sediment. Increasing the presence of fine sediment in the stream channel is more likely to be adverse than beneficial to chinook.

Gravel Transport

The gravel sizes most suitable for salmon spawning and benthic invertebrate production are not replenished in the stream reaches directly downstream of the project. That is because such gravels settle out as the river velocity slows upon entering the upper end of the HHD reservoir. WDFW reported a lack of spawning gravels in the gorge as early as the 1970s (Williams, et.al, 1975). Therefore, the proposed action includes a plan of gravel augmentation. The plan includes specific monitoring and an adaptive management component to ensure that specific measurable targets will be met. These measures should reduce, although not fully offset, the effects of present and ongoing HHD project operations on gravel transport. However, as under the sediment management plan framework, the adaptive management process should identify the appropriate amount of gravel augmentation. Under that framework, that amount would subsequently be identified in the sediment management plan and delivered to the system or reinitiation of consultation could be undertaken.

Large Woody Debris (LWD) Transport

Woody debris is an important component of salmonid habitat because it provides habitat space (pools) and structure (cover). LWD provides habitat and food for aquatic invertebrates important in the salmonid food chain. Structurally, LWD helps retain local deposits of spawning gravel in reaches where the sediment transport capacity exceeds the rate of supply, contributes to bank stability, and can be integral to channel migration processes in alluvial reaches. Under the existing baseline, in-channel LWD has been removed from much of the Green River basin as a result of timber harvest practices prior to 1975, flood control, and clearing by private individuals to facilitate recreational boating.

Recruitment of new wood to the river throughout the basin has been reduced by management actions as well as human-induced changes in fluvial processes. Ambient sources of LWD have been limited through historic and present timber harvest in the upper watershed. Furthermore, land clearing for rural and suburban development has contributed to decreased sources of LWD recruitment in the middle and lower Green River.

Construction of HHD created a physical blockage to the downstream transport of wood originating in the headwaters. Flood control operations at HHD prevent large channel altering flows. Because of the combined effects of flood control and channelization, levee construction, and channel revetments, the rate of channel migration has decreased in the middle Green River. Decreased channel migration has effectively stopped the movement of the channel into wooded areas that could provide these important habitat forming materials to the channel.

Operation and maintenance of HHD and development of the AWSP would maintain the existing blockage of LWD from the upper watershed. However, the incorporation of restored LWD transportation downstream of HHD would minimize the effects of that blockage. Under the proposed action, at least 50% of the wood collected from the reservoir each year, including up to five truckloads of small woody debris per year, would be transported past the HHD project. Furthermore, monitoring and evaluation of the effectiveness of this measures will inform changes

to the proposed regime that could be initiated at the request of NMFS. Therefore, although sources of LWD recruitment above and below the HHD project have been and will continue to remain reduced, the proposed action will improve LWD transport over baseline conditions.

Channel morphology

Changes in the channel morphology of the Green River affect the quality and distribution of aquatic habitat conditions in the Green River. In the HHD reservoir, approximately 4.6 miles of former riverine habitat is seasonally transformed into lacustrine habitat as a result of flood control and conservation storage operation at HHD.

Operation of HHD has altered the hydrologic regime of the Green River by preventing flows greater than 12,000 cfs at Auburn. The reduction in peak flows may increase the net fine sediment transport capacity of the river by prolonging near bank full discharges, and could be considered to benefit salmon incubation by reducing net deposition of fine sediment. Peak flood events scour gravels to a deeper depth than smaller flow events and the reduction in peak flood events may be particularly beneficial to salmon laying eggs deep in the gravel substrate.

While flood control may reduce peak scour events, operation of HHD has increased the frequency and duration of 3,000 to 9,000 cfs flow events (Corps 1998b). Since gravel transport in the Flaming Geyser reach of the Green River increases as flows increase over 2,900 cfs (Corps 1998b), flood control may cause a net increase in annual gravel scour and sediment transport. Flood control results in a net decrease in scour and a net increase in survival of chinook eggs.

Since construction of HHD in 1964, the channel in the lower Green River has narrowed, and formerly active gravel bars have stabilized because of the encroachment of riparian vegetation (Perkins 1993; Perkins 1999). These changes are associated with reduction in flood flows (Perkins 1999). Construction and maintenance of dikes and levees by King County and other municipalities also reduced the width of the lower Green River channel. Degradation of the channel in response to the decreased supply of coarse sediment might have occurred in the reach between Tacoma's Headworks and Palmer (RM 61 to RM 58). Narrow channels increase the velocity at a given flow compared to wider channels and increase the likelihood of redd damage associated with gravel scour. For these reasons, channel morphology is considered to be functioning at risk in the Green River.

Under the proposed wood and sediment management programs, present channel complexity would be maintained or improved (would become more complex). Distribution of LWD and sediment would improve, increasing the number and complexity of pools and the amount of spawning gravel, particularly in reaches that currently lack adequate sediment storage sites. Additional side channels could form in response to the increased wood and sediment load. The connectivity of existing side channels would be maintained or enhanced. The overall effect of these actions would be an improvement in channel morphology over baseline conditions based on the effects of the dam on channel morphology.

The effect of continued HHD operations under the proposed action are moderate compared to the environmental baseline. The project will continue to adversely interfere with habitat forming and maintenance processes that are critical to chinook. The conservation measures under the proposed action will minimize, but not eliminate the adverse baseline effects.

Summer Conservation Flows

Under baseline conditions, the Green River experiences natural (generally seasonal) and artificial low flows (caused by storage and diversion). Conservation flows would augment naturally and artificially occurring low flows in the Green River downstream of HHD. These flows would be particularly effective when, for example, Tacoma diverts up to 113 cfs under its first diversion water right and during periods of low natural streamflow. Without flow augmentation the river dries up average of one in five years. Use of flow augmentation could address the effects of Tacoma's withdrawal on juvenile fish rearing, incubation, and adult upstream migration. The baseline effect is primarily one of a reduction in preferred habitat for juvenile rearing for chinook that rear for up to a year in freshwater.

Low flows disconnect or dewater some side channels, a preferred habitat type. The adverse effects of this disconnection can be partially offset by a corresponding increase in shallow, slow velocity water in the main river channel. However, many of the cover types preferred by rearing juveniles are not available at low flows. Therefore, summer conservation flows would have a beneficial effect on fish, including chinook salmon, by very slightly increasing water depth and velocity, and cooling water temperature.

The benefits of the summer conservation flows are made possible only through water storage. Therefore, these benefits must be balanced against the potential adverse effects of storage, described above.

Water quality

Elements of water quality that the Corp analyzed included temperature, dissolved oxygen (DO), saltwater wedge, total dissolved gases (TDG), turbidity, and contaminants. The AWSP will provide improved ability to lower water temperatures in the Green River. Low flow augmentation reduces water temperatures in the middle and lower Green River.

Although DO is occasionally decreased in the lower Green River, this source of water quality degradation is not attributable to maintenance and operation of the HHD. Nor, does HHD affect the saltwater wedge, which sometimes extends upstream to RM 11 under low flow conditions. Under the proposed action, flow augmentation measures under the proposed summer conservation flows may shift the wedge downstream. There is no indication that HHD influences TDG. The proposed action includes monitoring to confirm that the project does not affect TDG.

Turbidity intermittently exceeds Class AA standards in the Green River upstream of HHD. Under present operations, HHD modifies the timing and duration of turbidity downstream of the project. While there is no indication that normally observed levels of turbidity directly adversely

affects chinook, it can limit water suitability for Tacoma's water supply. However, managing stored water to minimize turbidity for Tacoma's benefit may adversely affect chinook. Adverse effects may occur by releasing water supply that is intended to meet fish flows at a later date for migration, spawning, or incubation.

Contaminants that presently adversely affect chinook salmon in the lower Green and Duwamish Rivers are from sources other than HHD. Nothing under the proposed action would change the present levels or affects of contaminants from baseline conditions in the action area.

B. Indirect Effects

Indirect effects are defined above. Proposed operations might cause indirect effects on flood plain connectivity. Under the environmental baseline, historic HHD operations did not directly reduce flood plain connectivity. Rather, it was the construction of dikes, levees, road, and railroad along the lower Green River that has contributed to extensively disconnecting the flood plain from the river that followed the development of the HHD. Therefore, past HHD operations have indirectly contributed to the adverse affect of flood plain disconnection.

To address these historic indirect effects, the proposed action includes conservation measures to enable reconnection and enhancement of suitable side channels. Thus, the potential for future indirect effects in the form of flood plain and side channel disconnection would be minimized. These measures will lead to conditions improving over the environmental baseline.

C. Effects on Critical Habitat

The direct and indirect effects discussed above accrue mainly to Critical Habitat and not the fish themselves. These include flood control, spring storage, gravel and LWD transport, channel morphology, summer conservation flows, water quality, and flood plain connectivity. Some of these factors, like flood control, spring storage, and summer conservation flows have both beneficial and adverse effects on chinook.

The proposed action both modifies critical habitat and addresses habitat modification in several ways. Most profoundly, the fish passage conservation measure addresses the existing blockage of access to the upper river basin. The expanded reservoir associated with increased storage slightly reduces availability of potential spawning habitat (although there is no indication that spawning habitat is a limiting factor to the chinook population). Restored access increases the range and distribution of chinook spawning in the basin, a characteristic that promotes an unquantified increase in population diversity. In addition, the expanded reservoir can increase the supply of shallow, low velocity habitat preferred by juvenile chinook, a habitat type that is presently limited.

Restored access will reintroduce other species into the upper basin as well. Coho salmon and steelhead trout will spawn and rear there as well. Chinook already occur in sympatry with these fish in the lower Green River basin, and no unusual or adverse effects are expected as a result of this multi-species restoration.

D. Cumulative Effects

Cumulative effects are defined in 50 C.F.R. 402.02 as "those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation." The Action Area for this consultation consists of areas that would be either directly or indirectly affected by continued operations and maintenance of HHD and development and operation of the AWSP. In general, this consists of the Green River watershed upstream of HHD, HHD and associated Corps facilities, and the mainstem Green River and associated flood plain areas downstream of HHD to the Duwamish estuary that are inundated by flows of up to 12,000 cfs. Future Federal actions will be reviewed through separate section 7 consultation processes. Therefore, these actions are not considered cumulative to the proposed action.

Habitat quality is influenced largely by land use and management. The Green River upstream of HHD is managed primarily as timberland by public and private entities. The Washington Department of Natural Resources (DNR) manages over 20,000 acres under its Habitat Conservation Plan (HCP). Plum Creek Timber Company owns 50,000 acres in the upper basin. These lands are also covered by an HCP. Tacoma Water owns 15,000 acres and is presently concluding an HCP with USFWS and NMFS. These HCPs are expected to improve both terrestrial and aquatic habitat above baseline conditions. Other private timberland owners manage their property under the Washington Forest Practices Act. The terms of the FPA updated again in 1999 to improve habitat conditions. The expected outcome is a gradual improvement in habitat conditions for chinook salmon in the upper basin.

Continued growth and development is expected in the lower basin. Developmental actions that come under the banner of cumulative effects are those limited to state and local jurisdiction. These jurisdictions authorize actions that affect chinook under a Wild Salmonid Policy, wild stock restoration initiative, hatchery and harvest management, the Shorelines Management Act, the Growth Management Act, and King County's participation in the Tri-County Initiative to Recover Puget Sound Chinook. Realistically, we need to include those numerous unknown and unauthorized land use and management actions that typically affect chinook salmon both directly and indirectly. These range from activities such as poaching and chemical spills and applications to modest hydromodifications to tributaries in the form of clearing, diking, and adding impervious surfaces. The expected outcome downstream of HHD is the continued gradual degradation of chinook habitat and direct loss of fish.

VI. CONCLUSION

NMFS has determined that, based on the available information, the operation and maintenance of HHD and development and implementation of the AWSP is not likely to jeopardize the continued existence of Green River chinook salmon or result in the destruction or adverse modification of critical habitat. It is the collection of conservation measures, specifically the fish passage facilities and their operation, that reverses the adverse modification of critical habitat by restoring anadromous fish access to the upper river basin.

There is not a significant difference in the effects caused by the continuing operation and maintenance of HHD with or without the AWSP. The AWSP causes comparatively small additional incremental effects to chinook salmon and their habitat in specific effect categories. The expanded reservoir and storage of the AWSP causes the minor effect of reducing potential spawning habitat, but increases juvenile rearing habitat. However, that also is expected to cause an incremental reduction in the FGE of the juvenile passage facility. The increase in storage is not expected to reduce lower river outmigrant survival because of the inclusion of artificial freshets. Water temperatures could be reduced through the low flow augmentation provided by the AWSP.

Fine sediment flushing under the proposed action may adversely affect chinook salmon during the egg incubation or pre-emergent life history stage, but it won't jeopardize their continued existence. The natural production of chinook salmon is expected to occur in the future both upstream and downstream of HHD and in certain tributaries of the Green River like Soos Creek. Sediment flushing will have no effect on chinook upstream of HHD nor on those chinook in Soos Creek. Sediment flushing may further degrade the incubation environment of critical habitat in the lower Green River. Flushing the accumulated sediment of 38 years of project operation might trigger destruction or adverse modification thresholds for critical habitat, although high sediment loads, including fine sediment, are normal to the experience and critical habitat utilized by Puget Sound chinook throughout their range.

A prudent course of action with respect to sediment flushing is for NMFS to grant incidental take for two years, limiting any sediment flushing to actions coordinated with and specifically approved, or pre-approved, by NMFS and USFWS. After two years, the Corps shall reinitiate consultation with NMFS based on the development of the proposed sediment management plan and the results of coordinated sediment flushing actions. Future modifications of the existing regime would be contingent on that subsequent consultation.

In the PBA, the Corps determined that the proposed action would affect, although not likely adversely affect chinook salmon. NMFS disagrees with this determination because take occurs under present operations and under the proposed action. In each case, imperfect downstream passage of juvenile chinook is predicted and estimated. The point estimate is 64% FGE, resulting in an estimated 36% of upper basin chinook smolts lost to population productivity. The proposed conservation measures would minimize impacts, including take of chinook, from presently unknown and unquantifiable levels to lower, yet still unknown, levels. The PBA did not provide a basis for concluding that the proposed action would not likely adversely affect

chinook. The proposed action, with the proposed conservation measures, are expected to reduce take to an acceptable level.

VII. INCIDENTAL TAKE STATEMENT

Sections 4 (d) and 9 of the ESA prohibit any taking (harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, collect, or attempt to engage in any such conduct) of listed species without a specific permit or exemption. Harm is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patters such as breeding, feeding, and sheltering. Harass is defined as actions that create the likelihood of injuring listed species to such an extent as to significantly alter normal behavior patterns which include, but are not limited to, breeding, feeding, and sheltering. Incidental take is take of listed animal species that results from, but is not the purpose of, the Federal agency or the applicant carrying out an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to, and not intended as part of, the agency action is not considered prohibited taking provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary; they must be implemented by the action agency so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, in order for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered in this incidental take statement.

A. Amount or Extent of the Take

Most of the incidental take resulting under present operations and continuing under the proposed action is presently not quantified and is probably unknowable. Incidental take attributable to downstream fish passage under the proposed action can be estimated but not specifically quantified (in terms of individual fish numbers). Downstream fish passage is probably limited to the imperfect (64%) FGE associated with the proposed downstream fish passage facility. There is no juvenile passage facility that would be expected to have no adverse effect. However, the baseline condition has no passage facilities, upstream or down. Therefore the proposed action represents an improvement over the environmental baseline.

Fine sediment flushing from HHD has a significant potential to take listed chinook. Incidental take due to sediment management and sediment flushing actions are granted for a period of two years, subject to the terms and conditions below.

The proposed conservation measures are expected to reduce take to acceptably low levels. The proposed measures include a monitoring element to verify their effects on chinook and or habitat. The adaptive management approach permits future modifications so that the objectives of minimizing adverse affects and improving habitat conditions will be achieved.

B. Effect of the Take

In this biological opinion, NMFS has determined that the level of anticipated take is not likely to result in jeopardy to the listed species or in destruction or adverse modification of its critical habitat when the reasonable and prudent measures identified as conservation measures are included. The effect of the take is expected to be low and largely unknowable, except for the imperfect FGE for downstream juvenile fish passage.

C. Reasonable and Prudent Measures

NMFS believes that the following reasonable and prudent measures are necessary and appropriate to minimize take of Puget Sound chinook in the Green River under the proposed action. These reasonable and prudent measures are necessary to the continued operation and maintenance of HHD, with or without the AWSP.

1) The Corps will minimize take by providing upstream fish passage at Tacoma's headworks dam.

2) The Corps will minimize take by providing downstream fish passage facility at HHD to elevation 1177. The Corps will further minimize take by using the downstream fish passage facility to control downstream water temperature.

3) The Corps will minimize take by allowing large woody debris to pass the HHD.

4) The Corps will minimize take by augmenting gravel downstream of HHD at Palmer and Flaming Geyser.

5) The Corps will minimize take by developing and implementing a sediment management plan.

6) The Corps will minimize take by managing water storage and release at HHD.

7) The Corps will minimize take by monitoring the affects of the action on habitat functions as described in the PBA.

8) The Corps will minimize take through several additional habitat improvement actions.

D. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Corps must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are non-discretionary.

1) The Corps shall implement RPM #1 by constructing an upstream passage facility at the City of Tacoma's headworks. The Corps shall operate and monitor the upstream passage facility as described in the PBA and as summarized in the BO. Under the AWSP, that Corp shall use

funding from the City of Tacoma for the construction and operation of this facility. The details and specifications of the upstream passage facility are provided in the PBA and incorporated into this Term and Condition, by reference.

2) The Corps shall implement RPM #2 by constructing a downstream passage facility at HHD. The Corps shall operate and monitor the downstream passage facility as described in the PBA and summarized in the BO. The details and specifications of the downstream passage facility are described in the PBA and summarized in the BO, and are incorporated into this Term and Condition, by reference.

3) The Corps shall implement RPM #3 by operating the HHD to enable the passage or transport of 50% of large woody debris collected from the reservoir each year, including all pieces of wood equal to or greater than 12 inches in diameter and equal to or greater than 20-feet long. Rootwads shall be left attached, and large pieces shall not be cut. Further details regarding the passage of LWD are provided in the PBA and incorporated here, by reference.

4) The Corps shall implement RPM #4 by augmenting gravel downstream of HHD. The amount of gravel augmentation shall restore the functional equilibrium disrupted by HHD. Screened gravel, as described in Table 1, Appendix F1, of the AWSP EIS, one-half inch and larger shall be used. The amount of gravel augmentation will be derived by the Corps in direct coordination with the NMFS, and in strict compliance with the sediment management planning framework described in the PBA and summarized in the BO. The details of that framework are incorporated in this Term and Condition, by reference.

5) The Corps shall implement RPM #5 by developing and implementing a Sediment Management Plan within two years of the completion of this formal consultation. During this two year interim the Corps shall limit any sediment flushing to actions coordinated with and specifically approved by NMFS and USFWS. After two years, the Corps shall reinitiate consultation with NMFS based on the development of the proposed Sediment Management Plan. The sediment management plan shall describe specific measures designed to achieve the sediment flushing objectives developed in the sediment management plan. The Sediment Management Plan shall include a monitoring plan to ensure that the objectives are being achieved, including the protection of Puget Sound chinook salmon habitat. The proposed Sediment Management Plan will constitute new information and shall be grounds for reinitiating formal consultation, supplementing the PBA.

6) The Corps shall implement RPM #6 by managing water storage and release at HHD to minimize adverse effects on listed chinook. Water storage management measures will include:

a) maximizing the outflow through the fish passage facility by minimizing the reservoir refill rate during smolt out-migration and the potential use of periodic artificial freshets that mimic natural freshets;

b) increasing downstream survival of out migrating salmonids by maintaining a target base flow in coordination with the Green River Coordinating Committee (GRCC) and providing the option to release periodic freshets during peak out-migration;

c) partially mitigating downstream effects of storage by maintaining a coordinated target base flow that improves side channel and lateral mainstem rearing habitats;
d) providing annual storage of 5,000 ac-ft for low-flow augmentation (currently Section 1135 Project water is stored during drought conditions expected one in every five years);
e) reconnection of approximately 3.4 acres of side-channel habitat to the mainstem middle Green River; — COST SHARE
f) habitat rehabilitation including large woody debris (LWD) placement and excavation or reconnection of off-channel habitats to selected streams as described in the AWSP between the elevations of 1,177 feet and 1,240 feet. COST SHARE

7) The Corps shall implement RPM #7 by monitoring the action for the above and other elements of the action. The details of the monitoring program are described in the PBA and incorporated in this Term and Condition, by reference. Adaptive management is part of the AWSP proposal. Monitoring is a necessary adjunct to assessing the efficacy of the conservation measures and making suitable modifications.

8) The Corps shall implement RPM#8 by performing the following habitat improvement actions according to the detailed descriptions provided in the PBA:
a) return of the river to its historic channel between RM 83.0 and 84.0 using one or more debris jams/flow deflectors; M
b) maintenance of instream and riparian corridor habitat within the reservoir inundation zone (elevation 1,141 feet to 1,167 feet); M
c) maintenance of stream and riparian corridor habitat in lower Page Mill Creek, creation of a series of new, smaller ponds, and addition of woody debris to the ponds and stream channel; M
d) replacement of culverts that constitute barriers to upstream or downstream fish passage in tributaries to the Green River (locations to be identified from a culvert inventory); M
e) improvement of habitat in the mainstem Green River below HHD by constructing engineered log-jams and limited excavation to recreate meanders or backwater habitats. M/R

9) In addition to implementing the eight RPMs provided in this biological opinion, the Corps shall meet annually with NMFS during the construction phase to determine that project elements scheduled for construction or implementation in the subsequent 12 month period fall within the scope of the PBA and this BO.

VIII. REINITIATION OF CONSULTATION

Consultation must be reinitiated if: the amount or extent of taking specified in the Incidental Take Statement is exceeded, or is expected to be exceeded; new information reveals effects of the action may affect listed species in a way not previously considered; the action is modified in a way that causes an effect on listed species that was not previously considered; or, a new species is listed or critical habitat is designated that may be affected by the action (50 CFR 402.16).

In addition to the criteria described above, Consultation must be reinitiated to permit the evaluation of the proposed sediment management plan and any envisioned sediment routing through HHD that would intentionally occur under that plan when it is completed. Furthermore, the failure of any of the proposed conservation measures to meet the effectiveness described in the PBA or this BO, according to monitoring and reporting that will occur thereunder, shall be grounds for reinitiating consultation.

IX. LITERATURE CITED

Section 7(a)(2) of the ESA requires biological opinions to be based on "the best scientific and commercial data available." This section identifies the data used in developing this opinion.

Dilley, S.J., and R.C. Wunderlich. 1992. Juvenile anadromous fish passage at Howard Hanson Project, Green River, Washington, 1991. U.S. Fish and Wildlife Service, Western Washington Fishery Resource Office, Olympia, WA. 69p.

Dilley, S.J., and R.C. Wunderlich. 1993. Juvenile anadromous fish passage at Howard Hanson Project, Green River, Washington, 1992. U.S. Fish and Wildlife Service, Western Washington Fishery Resource Office, Olympia, WA. 73p.

Grette, G.B. and E.O. Salo. 1986. The status of anadromous fishes of the Green/Duwamish River System. Prepared for the U.S. Army Corps of Engineers, Seattle Region. 213p.

Groot, C. and L. Margolis; eds. 1991. Pacific Salmon Life Histories, Dept. of Fisheries and Oceans. UBC Press.

Healey, M.C. 1991. Life history of chinook salmon *(Oncorhynchus tshawytscha)* in C. Groot and L. Margolis; eds. 1991. Pacific Salmon Life Histories, Dept. of Fisheries and Oceans. UBC Press, Vancouver, British Columbia.

Lister, D.B., and H.S. Genoe. 1970. Stream habitat utilization by cohabiting underyearlings of chinook *(Oncorhynchus tshawytscha)* and coho *(O. kisutch)* salmonids. Journal of Fisheries Research Board of Canada 27:1215-1224.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grant, F.W. Waknitz, K. Neeley, S.T. Lindley, and R.S. Waples. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. US. Dept. Commerce, NOAA Tech, Memo. NMFS-NWFSC-35, 443 p.

Perkins, S.J. 1993. Green River channel migration study. Prepared by King County Dept. of Public Works Surface Water Management Division, River Management Section. Seattle, WA. December 1993. 45p.

Perkins, S.J. 1999. Geomorphic evaluation of gravel placement in the Green River, Washington. Report prepared for Jones and Stokes Associates Inc., Bellevue Washington and the U.S. Army Corps of Engineers, Seattle District, Seattle Washington. 50p.

Williams, R.W., R.M. Laramie, and J.J. Ames. 1975. A catalog of Washington streams and salmon utilization, Volume 1: Puget Sound Region. Washington Dept. of Fisheries, Olympia, WA.

U.S. Army Corps of Engineers, Seattle District. 1998a. Water Control Manual. Howard Hanson Dam, Green River Washington. Cited in PBA.

U.S. Army Corps of Engineers, Seattle District. 1998b. Additional Water Storage Project, Draft Feasibility Report and Environmental Impact Statement, Howard Hanson Dam, Green River Washington.

WDFW and Western Washington Treaty Indian Tribes. 1994. 1992 Washington State salmon and steelhead stock inventory, Appendix One, Puget Sound Stocks, South Puget Sound Volume, Duwamish/Green Stock Data. Washington Dept. of Fish and Wildlife and Western Washington Treaty Tribes, Olympia, WA. 44p.